Towards Academic Writing with Substance

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This essay is a coherent response to the incoherent objectives of the First International Symposium on Academic Writing and Critical Thinking. The first step towards coherence is to recognise that artificially separating the roles of teacher and learner is inconsistent with the nature of teaching. Also, we reject the view that the *primary* aim of academic writing is "to convince readers to accept the paper's thesis statement by demonstrating the logical steps that lead to it". On the contrary, the primary aim ought to be to describe the grounds – the foundations – so persuasively that the required logical steps become very simple and transparent.

From the way of Go, the beauty of Japan and the Orient had fled. Everything had become science and regulation. – from "The Master of Go", Kawabata Yasunari

1. Introduction

This essay is a coherent response to the incoherent objectives of the First International Symposium on Academic Writing and Critical Thinking, held at Nagoya University in February 2013, which were: 1) "Of particular interest is logic and critical thinking in construction of academic arguments – academic writing beyond the sentence level" – in other words, answering the distinct philosophical questions "What is academic writing; how ought it be done?" and "What role does critical thinking play in academic writing?"; and 2) "A question of particular concern is how best to teach these skills to students writing in a foreign or second language" – in other words, expounding on the foreign-language teacher's viewpoint. Coherence is achieved by recognising that artificially separating the roles of teacher and learner is inconsistent with the nature of teaching: the teacher ought always be aware of the viewpoint of learners of a foreign or second language; and, *together with this*, the student ought to be placed in the role of the writer who is faced at any point in an essay with problems that require thought and solution, in a process that demonstrates what academic writing is according to the teacher, who has analysed the process of academic writing and construction of academic arguments and is conveying the principles in this immersive way. In other words, in the teaching process, the writer's viewpoint unites the teacher and student. Therefore this essay has two – only seemingly – disjoint main themes: "Logic and the Academic Essay Form", which is published here, and "Teaching Academic Writing; Teaching Critical Thinking", which will be published elsewhere. The latter is a practical guide for implementing the principles elucidated here, with examples relevant to teaching English as a second or other language in Japan.

2. Rejection of the Primacy of "Logical Thinking" in Academic Writing

Regarding the first incoherent objective of the symposium, we reject the view that the *primary* aim of academic writing is "to convince readers to accept the paper's thesis statement by demonstrating the logical steps that lead to it". On the contrary, the primary aim ought to be to describe the grounds – the foundations – so persuasively that the required logical steps

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become very simple and transparent. Ergo, we reject the assertion that the primary preoccupation of teaching academic writing ought to be the teaching of logical thinking skills. Furthermore, we object to making the “expression of logical sense through logical thinking” the *primary* focus of teaching and learning a foreign language: creating logical arguments that “make sense” and deceive the unwary has been a modus operandi of dictators, despots, politicians, snake-oil salesmen, dishonest academics, and scoundrels of every kind for centuries. Teaching how to express logical sense through logical thinking is equivalent to teaching students how to make up lies designed to deceive the credulous. The focus ought to be elsewhere.

This essay demolishes the assertion that “demonstrating logical steps is necessary for successful academic writing” by presenting brief examples from physics: these demonstrate a number of ways in which logical thinking has been violated in a work (paper, book, etc.) yet the work nevertheless became widely accepted, even famous, and is considered a significant achievement to this day. The example types can be taken as illustrating what Albert Einstein called “the essentially constructive and speculative nature of all thinking” in his 1946 repudiation of Ernst Mach’s positivism:

> He did not place in the correct light the essentially constructive and speculative nature of all thinking and more especially of scientific thinking; in consequence, he condemned theory precisely at those points where its constructive-speculative character comes to light unmistakably .... (Howard, 2004)

The example types are, in order: explicit internal, logical contradictions that were not recognised for centuries – yet nowadays the author is considered one of the greatest ever scientists (and, due to deference to his fame and lack of scrutiny, his work is usually taught with the contradictions unmodified and unnoted); implicit (i.e. unmentioned) internal, logical contradictions that are ignored because most readers believe that they do not affect the truth of the work – and explicitly demonstrating them does not change anything; explicit or implicit concepts that were considered important by the author as part of the starting point for a derivation but in hindsight turned out to be wrong – yet those author’s works form part of the core of modern physics; two completely spurious (i.e. without any *a priori* logical justification) postulates – in essence, lucky guesses – that became part of the foundation of modern physics; works that are completely internally consistent yet everybody knows that they are wrong (in the sense of having no correspondence in Nature) – and they are accepted as valid fields of endeavour; and, finally, works (e.g. first-year textbooks) that are internally consistent, wrong on many points, and accepted only by mediocre physicists and physics educators who have lost a serious connection with the subject and are all too often too busy cultivating a pseudoscientific (ostensibly “research-based”) cult in teaching methodology. It would be extremely simplistic – and wrong – to try to characterise the academic acceptance (or nonacceptance) described in the above examples as being due to their “having not only internal logic, but also reflecting external realities”; and that we thereby advocate merely that “critical writing should reflect external realities and not only internal logic”: the reality is far more complex. The examples presented in this essay demonstrate that logical arguments are neither necessary nor sufficient for academic writing. Far more important than logical thinking – and more worthy of focus in an academic writing course – are knowledge, truth value and clarity of expression. For the last of these, only simple logic is required. (To these we would add aesthetics – the study of form – because engagement with a critical audience requires the compression of enormous amounts of information, which in turn demands meticulous selection and presentation in an optimally economical manner, and this is achieved by mastering form: form is part of the content.)

The above examples all come from the field of physics, so the specious argument might be proffered that our objection can be confined to academic writing in physics, as if "physicist thought" is somehow utterly separated from the rest of human thinking. Notwithstanding the fact that the role of mathematics in providing isomorphisms with Nature is unique to physics and the mathematical sciences – Karl Popper in "The Poverty of Historicism" railed against the misuse of mathematics in the humanities, particularly the researchers seeking an "equation of motion" for society, as a dangerous attempt to bestow upon their field the prestige, certitude and universality of physics – there is plenty in physics academic writing that has nothing to do with "equations of motion in Nature" and which therefore connects it with all other academic writing. Moreover, it would be a futile exercise to enumerate fields – and journal style guides – one by one and adapt this present essay's argument to each one; for anybody can invent subdivisions within fields and then claim that, by the same token, "the thinking here is completely different to anything ever seen anywhere", a standard strategy of pedants and obscurantists, which would lead to every field disintegrating into disjoint fragments, everybody becoming king of their private castle thinking they are beyond criticism; and academic debate ceasing.

The principles propounded in this essay could be illustrated by considering, for example, the fields of history, palaeontology or cinema studies. The interpretation of prehistorical traces, historical events or cinematic scenes, and producing some consistent "picture" or "retelling" or "theory" based on them, contains the central problem of academic writing: a new piece of evidence can completely overturn the currently held view. This view can be a widely held scientific view, or the view that is currently being expressed at a local level within an essay (i.e. a generalised notion of "view"). Successful academic writing in this context lays down the knowledge as thoroughly as possible (or as required for its purpose) in the hope that some explanation will appear more plausible than others, even though no explanation can have overwhelming plausibility. There is no place for sophisticated logic here. The primary purpose of academic writing is to present knowledge coherently (which is a problem of expression of meaning) in the hope that it has truth value. The situation is basically the same even when an explanation can have overwhelming plausibility, even in a theoretical physics paper.

A careful analysis of the role of evidence in expressing meaning reveals several consequences. First, the foundation – the axioms (starting points of logical thought) – are only as good as the currently known evidence that supports them – as are any logical deductions based on them. Moreover, the possible axioms are dense in the set of (known or not yet known or presented) evidence – a small perturbation (slight change) of any axiom due to admitting extra evidence is likely to be plausible, even having truth value indistinguishable from the original axiom, yet the perturbed axiom can lead to a widely different conclusion or "theory". One of the main problems in academic writing is how to include enough evidence in support of one's axioms so that a variety of readers, with their own sets of evidence in mind, accept the axioms too. Successfully arguing for the starting point is the hardest part. Often, the conclusions follow easily once the axioms have been accepted.

Finally, what even constitutes evidence can be disputed by opposing parties, and choosing one set of evidence automatically biases one conclusion over another, because logical deduction is an automatic, machine-like internal process that guarantees some output given a specific input. This is analogous to choosing initial conditions for an ordinary differential equation: any final result (from some set) can be guaranteed by an appropriate choice of starting point. One can even create whatever behaviour is desired by inserting appropriate terms into the differential equation, which is analogous to increasing the sophistication of a logical deduction to arrive at whatever conclusion one wishes. These are the techniques of snake-oil salesmen and should be avoided: when it comes to using logic, the logic should be kept as simple as possible because any sophistication in the logical deductive chain can conceal sleight of hand.

3. Logic and the Academic Essay Form

"You say you want to buy a house? OK, we can finance that. Oh, you're unemployed. That's OK, we have a plan that will make your dream possible. Here's how it goes." During the housing boom a few years ago the financial plans and derivative instruments including them invariably made complete sense: they were eminently logical, which is why so many people bought them. To the unwary, deceived by appearance, the stepping stones between premise and conclusion appeared to be solid, but later those deals sparked a global financial crisis. The propositions and arguments appeared solid because the conclusions were jumped to too quickly; in their haste almost nobody noticed that the stepping stones comprising the foundations were porous, and soon the time came for the structures built on them to sink. It therefore seems that scrutiny of appearances that "make sense" ought to be the focus, not the "making sense" itself. Checking the validity of the premises is certainly a good place to start: the proposition that a person with no regular income can afford to buy a house should appear suspicious, calling for rigorous scrutiny of everything that is said afterwards to justify it. Importantly, when appraising an argument properly, and having smelled a rat, truth value is not drawn from the correctness of the logical form in the sense of predicate calculus and so on, nor the sophisticated application of Modus Tollens or operators like $\wedge$, $\vee$ and $\rightarrow$, because no matter how perfectly these are implemented, the argument could well be papering over more fundamental problems. On the contrary, truth value is drawn from deep knowledge of the subject and conscious subversion of appearance. You do the best you can undermining the foundation and watching for what topples over and what stays standing. You try to find a minimal set of axioms that seem believable, and that are far enough back towards the genesis of all the axioms presented by the "salesman" so that all the axioms seem well grounded. The logic, now stripped bare and utterly simple, falls into place naturally. In other words, it is the substance that counts.

We now demolish the assertion that logical thinking is necessary or sufficient in academic writing. To do this, it is necessary to consider several kinds of ways in which the primacy of logic has been rejected in the history of academic writing. We take physics as an example. It is surprisingly common for a scientific work's logical contradictions (e.g. lack of self-consistency) or other logical problems to be ignored by readers as they focus on the substance and not formal perfection. For example, it has been known since Ernst Mach (1912) that Newton's Three Laws of Motion are tautological, that only two laws are independent; yet "Newton's Three Laws" are still being taught in every introductory physics class and, moreover, they are taught with no attention drawn to their tautological nature. While a tautology is not, strictly speaking, a contradiction, "three" certainly does not equal "two", and the consequences are real: physics educators puzzle over why students have trouble understanding the "three laws", yet the answer is right under their noses. Students are being asked to make three out of two; i.e. to do the impossible, which practically means they will invent erroneous concepts to make their thinking fit the theory as it is presented. Turning a blind eye to the problem is mostly due to a combination of ignorance and lack of thought by physics educators about what they are doing. Despite the logical flaw of his theory, there's no denying that Newton's name deserves to be associated with the two laws that do exist and that his Principia, which contains the "three" laws, is a great body of work, even though statements are made in it which Newton would, in hindsight, have found quite embarrassing.

Another type of example of ignored contradiction is how physicists have driven mathematicians to despair for over a century with their sloppy maths. A famous example is the history of the Dirac delta function, which was invented by the physicist Dirac in 1930, and whose "proper" justification did not appear until the work of Schwartz in 1950. This kind of thing happens whenever the physicists get ahead of the mathematicians and the formalism is not properly understood: if you dig a little deeper you will find inconsistencies in the theory but these are peripheral to the “physics” and physicists don’t care because they “know” it works – and it does. Even if the contradictions are demonstrated explicitly – when a lively mathematician gets ahead of the physicists – it makes no difference because the physicists are convinced of the truth of the theory. A common example of this is vector calculus, in which physicists prefer the retro nineteenth-century terms of div, grad and curl, whereas every right-thinking mathematician knows that 1-forms and 2-forms should be used. On other occasions, a paper has made a famous contribution even though much of it is “wrong” in the sense that the conceptualisation surrounding the derived equations is shown later to be completely incorrect. Sometimes the conceptualisation is mentioned explicitly in the paper, and sometimes the author leaves it out because he senses that it is superfluous, but talks about it in other works. For example, in 1824 Carnot made a fundamental contribution to the Second Law of Thermodynamics even though he believed that heat was a substance that flowed like a liquid – the modern word *calorie* derives from *caloric*, the name of the mythical heat substance – but Joule’s experiment in 1845 showed that this cannot be so. Much of nineteenth-century physics dealt with a mythical substance allegedly filling all of space called the ether, whose existence the Michelson-Morley experiment in 1887 contradicted and Einstein in 1905 showed is impossible; Maxwell himself believed in the ether when he discovered his famous equations in 1873, even though Maxwell’s equations in fact do not require an ether and are correct even after taking into account relativity. Their truth transcended the milieu that gave birth to them. Nobody at the time knew any better, so Carnot and Maxwell can be forgiven; however, the point is that readers today, who do know better, ignore Carnot’s and Maxwell’s erroneous statements in and beyond their classic papers and instead celebrate the achievements at the core of the works that have survived the scrutiny of modern physics.

Sometimes a contradiction or spurious logical leap is acceptable because it points to a limitation of the current theory and the germ of a better one (even if the leap is mostly wrong!): contradictions and discontinuities contain information. For example, the Bohr model, appearing in 1913, tries to solve the radiative problem of the Rutherford atom (electrons traveling in circular orbits would radiate their energy away and fall into the nucleus) by inventing without any justification a condition (quantisation of angular momentum) that would keep the point-particle electrons in their orbits without radiating. Bohr more or less plucked the idea out of thin air, and he won a Nobel Prize for it in 1922. His work was a rudimentary precursor to the quantum mechanics of the 1920s. As another example, De Broglie guessed, with even less justification than Bohr offered for his theory, that electrons behave as waves and won a Nobel Prize for that in 1929. It was the only physics he ever did. Sometimes everybody knows that a theory is wrong, but it is nevertheless seriously pursued as a testing ground for various ideas and techniques: e.g. N=4 Super Yang-Mills theory. Evidently what is important is not watertight logic, but something akin to essence.

On the other hand, in physics it is easy to be completely logical and completely wrong. It can happen unintentionally for numerous kinds of reasons and at varying levels, as in these two cases: authors of elementary textbooks are prone to presenting cartoon explanations that lead to physical contradictions as soon as you scratch the surface – the thinking is often a relic of Victorian-era physics, comforting in its mistaken simplicity and frozen in time as if the twentieth century did not teach us anything; and mathematics underpins physics, but its watertight logic creates a closed world that can easily deviate from physical reality (because, say, the nature of a system changes completely when the temperature is lowered, which is an external input into the mathematical logic and not deducible from within it). The latter is certainly a case where external reality needs to inform the logic. So although it may seem tendentious to mention deceitful finance brokers' fraudulent sales techniques in the same breath as academic writing, the principle – and the principal danger – is the same. Academic writing in physics (and probably in anything) that relies on pristine logic and is otherwise empty of substance cannot be trusted; yet academic writing that contains glaring contradictions of one form or another might contain brilliant insights.

If we reject making the "expression of logical sense through logical thinking" the primary focus of academic writing, what do we replace it with? Since logical deduction is in any case a machine-like process – and your desired outcome can be guaranteed by your choice of starting point – the focus ought to be on presenting evidence to support your starting points. Moreover, since any sophistication in the logical deductive chain can conceal sleight of hand, the logic should be kept as simple as possible. In some contexts (e.g. theoretical physics), even a short deductive chain can invite scepticism and misunderstanding at every step, even if the starting point has been established. In this case, the intermediate steps must be supported by providing density of knowledge and meaning that show their correctness.

As a concrete example, we consider a theoretical physics paper by Olshanii (1998). The imperative to prevent sleight of hand concealed in either axiom choice or logical sophistication explains why authors of modern seminal works such as the paper by Olshanii go to great lengths to lay the accepted knowledge underpinning their argument bare, and through force of will attempt to ensure that at least one reading exists that makes misunderstanding unlikely. If the reader still doesn't get it, either it's the reader's own fault, or the author is wrong: further contemplation and conversation is then in order. Admittedly, in the Olshanii example there's a catch: he was writing for the pointy end of Nobel Prize aspirants, and he knew his audience well. These are usually vastly knowledgeable and intellectually brilliant readers who are habitually inclined to apply a blowtorch to colleagues' assertions without regard to social niceties, often because those possessed by the life of the mind are only vaguely aware of what these are. Logical sophistication is treated with contempt: they want reality, and logic without substance is not reality but empty posturing.

With the target journal enforcing a four-page limit, which includes all diagrams, tables and references, the salient features of Olshanii's derivation were banged into place with extreme prejudice, omitting the details that bring succour for mere mortals. The result is crude but effective. With lines like "We now write the final expression for the one dimensional scattering amplitude" and "The formula for the one dimensional scattering amplitude (11) is the key result of this paper", the style conjures the image of some carpenter-cum-sculptor assembling a sculpture of a voluptuous human model by nail-gunning planks of wood together. And as for logic, Olshanii invites the reader to reproduce the steps, but that is not the same as saying the reader will likely be able to decide for or against the key result on the basis of a couple of (or even many more) readings. A mere mortal would take weeks or months to reproduce the results, if he or she ever got that far. An invaluable tutorial paper that spells out the steps in detail is thirty pages long. In a nutshell, the urgency to get the message out and the awareness of a critical audience – and the need to persuade a small group of expert readers in particular – framed the paper to the extent that internal logic, in the sense of what you or I can follow without knowing much by applying self-contained logical rules, was banished from sight. Importantly, readers are – in principle – free to make up their own minds, to disagree if they think it necessary: the paper contains no ex cathedra pronouncements shoved down the readers' throats, simply because they are superfluous and would not contribute to any substantiation. Many specialists ended up agreeing with Olshanii, and the paper supercharged the field of ultra-low-temperature low-dimensional quantum many-body physics, which subsequently became a highly active field of research, particularly after the theory passed the ultimate test of being confirmed by experiment.

Olshanii's paper suggests certain principles for writing for academic purposes, and for teaching academic writing. Fundamentally, academic writing is a process of establishing the ground beneath the starting points and midpoints of an argument: every logical progression occurs amidst a dense context that has already been established by the writer. In the writing process, the key idea is that background material is continually injected into the essay's world that is not deducible from within it. The literary skill to be mastered by both teacher and student is how to shape the injection process. We create meaning rather than just make sense, and the difference is crucial: something urgent needs to be communicated that might not fit in smoothly with what has gone before it, and we have to figure out how to get away with it by solving literary, semantic, syntactic or logical problems.

Olshanii's paper shows that if the message itself can be so important that it ends up transforming an entire field, perhaps when teaching academic writing we ought to place greater emphasis on the *idea* rather than the *technology* (sophistication of logical argument). We ought to encourage reasonably clear communication of the most urgent thing together with grounds for why the audience should believe it – that's *grounds* rather than *logic*. Of course the writer must have decided that something is worth saying urgently in the first place, which requires guided preparation. We constantly scrutinise the appearance we are creating and undermine it to find its weak points: when a part collapses we rebuild a strengthened version; or we might smash what we have written and find a better way of putting the pieces together with the glue of deeper knowledge or a better insight into the overall form that the substance demands. Logic and linguistic niceties play a secondary role insofar as their absence does not impede communication of the main message. The gear wheels and strings linking the logical steps need not be exposed. The only rules are that the progression of ideas from introduction to conclusion ought to be self-consistent so that the main message is clear, and that it ought to impress the reader with a feeling of unity – and even these rules need not be fanatically enforced since an apparent contradiction, such as the one inherent in Bohr's theory of the atom (the electron has to be described by something like a wave function, not a point), might simply be inviting the reader to devise a more sophisticated understanding or a better theory; and the essay's unity need not be signalled with bells and whistles throughout, but perhaps be revealed only in the final paragraph. The teacher helps the student do this, giving feedback on the impressions the writing is making while it is in progress.

4. Concluding Remarks

Fundamentally, academic writing is a process of establishing the ground beneath the starting points and midpoints of an argument: every logical progression occurs amidst a dense context that has already been established by the writer. Logical progressions are kept as simple as possible. In the writing process, the key idea is that background material is continually injected into the essay's world that is not deducible from within it. The literary skill to be mastered is how to shape the injection process. The empty page is like a blank canvas: we create meaning rather than just make sense.

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